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AUTHOR ten Brummelhuis, Alfons; Plomp, Tjeerd
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ABSTRACT

Using data from an international comparative study on the use of new technologies in education in about 22 countries, an assessment of the relation between problem areas and stages of computer implementation was undertaken. The study--"Computers in Education" (COMPED)--has been conducted since 1987 by the International Association for the Evaluation of Educational Achievement (IEA). The COMPED assesses national policies regarding the goals of computer education and the actual use of computers, school plans and implementation of plans, experiences and opinions of teachers, and the effect of innovations at the student level. National policy, school policy, and teacher questionnaires are used to collect data on both elementary and secondary educational levels. Exploratory and contrast analyses were performed on study data. Results indicate that the most important problems of computer users are, at the same time, the most important reasons given by non-users for non-use. The problems with implementing computer technology in education, experienced by principals, computer coordinators, and teachers, are related to conditional factors, such as lack of hardware, software, knowledge, and time. The most important differences between schools with low and high levels of computer use are associated with organizational problems. Six tables are included. (TJH)

THE RELATION BETWEEN PROBLEM AREAS AND STAGES OF COMPUTER IMPLEMENTATION

by
Alfons ten Brummelhuis and Tjeerd Plomp

Department of Education
University of Twente
P.O.Box 217
7500 AE Enschede, the Netherlands

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Department of Education
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7500 AE Enschede, the Netherlands

Introduction

Since 1987 IEA, the International Association for the Evaluation of Educational Achievement, have conducted an international comparative empirical study on the use and impact of introducing new technologies (especially computers) in education in about 22 countries. The first data collection in this 'Computers in Education' (COMPED) study took place in 1989.
The major aims of the study are to provide data about:

1. The national policies regarding the goals of computer education and the actual use of computers.
2. What schools are planning to do and actually are doing with computers.
3. What experiences and opinions teachers have.
4. What the ultimate effect of the innovations is at student level.

Analyses of the international database may show in which areas promising developments are going on, which problems need to be resolved and how implementation of computers in education is correlated with other variables.

Participating countries

The following countries or educational systems participated in stage 1 of the study: Austria, Belgium (Flemish), Belgium (French), China, Israel, Italy, Canada, (British Columbia), Japan, Luxembourg, France, F.R. Germany, Greece, Hong Kong, Hungary, India, the Netherlands, New Zealand, Poland, Portugal, Spain, Switzerland and the USA.

Instruments

National policy data were collected with a questionnaire that addresses issues like national policies for example with respect to hardware provision, courseware development, teacher training, budgets and innovation strategy. A Principal and Computer Coordinator Questionnaire address issues like school policies in using

computers, availability and acquisition of hard- and software, organization of computer use on school level, support, equity, attitudes and school characteristics. Questionnaires for teachers of Computer Education, Mathematics, Science and Mother Tongue collect data about computer education, types of computer use, frequency of use, time spenditure, curriculum content covered, attitudes, teacher knowledge and skills and teacher training.

Populations and samples

Three populations were defined. Population I covers the final grades of elementary education. Population II is lower secondary education and Population III is upper secondary education. Representative stratified random samples of schools and teachers in schools were drawn for each country. A distinction was made between schools using and not using computers, and within computers using schools between computer using and non-using teachers.

Planning of the study

The study is executed in two stages. Stage 1 lasted 4 years (1987-1990) and involved collecting data on national-, school- and teacher level. In 1989 most of the participating countries collected data in national representative samples of schools and teachers. Countries also completed a National Case Study Questionnaire about national policies with regard to the introduction of computers in education. Stage 2 will last 4 years (1991-1994) and consists of a replication of the collection of the Stage 1 data in 1992 in order to study the pace of developments. Beside that data with respect to student achievement (e.g. computer literacy, skills, etc.) and attitudes will be collected. A first international report of the Study is Pelgrum and Plomp (1991).

Research questions

The introduction of computers in education is a complex innovation in which many obstacles need to be overcome before one can speak of a successful implementation. When the Comped study was designed during 1985-1987, it was known that in many countries the number of computers in schools had increased considerably over the years. Yet, it was reported that little progress had been made in integrating computers in existing lesson practices: few teachers were actual users, software use was often restricted to drill and practice activities, and the integration of computers in the curriculum was poor (Pelgrum & Plomp, 1991; p.4).

From the literature on the implementation of innovations, we know that there are four categories of important factors for a successful integration of computers in education: national context, school organization, external support, and innovation characteristics (Fullan, Miles & Anderson, 1988; Van den Akker, Keursten & Plomp; in press). Restricting ourselves to only the two categories which refer most to school problems, typical problems which may hamper the introduction of computers on school level are:

with respect to *school organization*:

- lack of encouragement and support from school administrators and principals, especially in the provision of facilities for training, acquisition of hardware and software, rearrangements of time tables, and other organizational measures;
- the school climate is negative and teachers are not mutually supportive;
- there is no long term security of supply and maintenance of hardware and software;

with respect to *innovation characteristics*:

- need and relevance: is there a need for using computers, and what is the priority of computer usage in comparison with other concerns?
- clarity: how clear are the goals, the essential features, and the practical implications of computer use for those who are supposed to work with computers in the schools?
- complexity: how difficult is it to introduce computers in the curriculum and the instructional practice, and how drastic are deviations from existing practices and beliefs?
- quality and practicality: how well developed and tested are the educational software products, and to what extent is the expected impact empirically proven?

This kind of questions are often asked by teachers and other practitioners, who ultimately are the central actors in the implemention of computers in educational practice. Weaknesses in one or more of the categories mentioned above may cause major obstructions in the implementation of computers on school and classroom level.

Pelgrum and Plomp (1991) report that integration of computers in the practices of the schools is developing very gradually: many schools use computers for instructional activities, schools do have a fair amount of educational software, and the number of teachers involved in using computers is yearly increasing in all participating countries. However, they also conclude that in many countries only a small percentage of teachers in secondary schools use computers in their lessons. The kind of use is rather traditional because drill & practice is most frequently mentioned as a didactical approach for computer use. From an implementation perspective in many countries the introduction of computers is in an early stage. On the other hand, they call it promising that in the USA in four years time about twice as many teachers of mathematics, science and mother tongue were going to use computers in their lessons.

In order to explore in what areas policy makers, support institutions and school administrators might take measures for improving the process of implementing computers in educational practice, one might look at the problems users of computers are experiencing, and at the reasons why non-users say they are still non-users. In the Comped study principals, computer coordinators and teachers in computer using schools were asked to indicate in a list of 28 potential obstacles what they in their situation, and from their perspective see as problems which are hampering the introduction of computers in their school and classroom practice, while principals from non-using schools and non-using teachers were asked to indicate in the same list their reasons for not being involved with computers for instructional purposes.

In this paper we will analyze the data for lower secondary education from four countries: France, Japan, the Netherlands, and the USA. These countries are selected

for this analysis for, amongst others, the following reasons:

- France has a centralized educational system; already in the late 1970s the French government took the initiative for a national policy for introducing computers in secondary schools; France also stimulated courseware development on a national level, and schools received vouchers to buy 'nationally approved' courseware;
- Japan, being in many respects an example for other industrialized countries, started only recently (1985) with an active stimulation policy in this area; Japan has a centralized educational system;
- the Netherlands in principle has a decentralized educational system, but the national government developed from the early 1980's a very active stimulation policy with respect to the introduction of computers in education; between 1985 and 1989 all junior secondary schools were equipped with 11 MS-DOS computers (partly in a network) and received programs such as a word processor, database, spreadsheet, while also a national teacher inservice training program was implemented, and a national courseware development project was established;
- the USA, having a decentralized educational system (education is a responsibility of the states and the counties) is known as the country that is the fore-runner in this area. Pelgrum and Plomp (1991) show that roughly spoken the developments in many industrialized countries in 1989 were at the same level as in the USA in 1985-1986.

In summary, the research questions addressed in this paper are:

- which problems do computer users experience at school and classroom level in using computers, and what are the reasons for non-users for their not being involved in using computers for instructional purpose?
- are there any relationships between the degree of implementation of computer use at school level and the type of problems that are experienced?

In the next section we first will present some context data about the instruments used and the respondents. Then an exploratory analysis of the problems of users and the reasons of the non-users will be given, followed by an analysis in which intensive using schools are being contrasted with 'light' using schools. In the last section some conclusions and recommendations for policy makers at school level and beyond will be proposed.

Some context data

In France, Japan, the Netherlands and the USA, data were collected *in computer using schools* from principals, computer coordinators, teachers of computer education (often called computer literacy, informatics, etc), and from computer using as well as non-using teachers of mathematics, science and mother tongue (called teachers of existing subjects). It appeared that in 1989 an introductory course in computer education was

being taught in schools in 24% of the lower secondary schools in Japan, in 92% of these schools in the Netherlands and in 53% in the USA. However, in France 'teaching about computers' is a separate course only in a small percentage of lower secondary schools (10%); in the other schools this is part of other courses, for example general technology (54%), or mathematics (13%). Therefore for France all using teacher data are aggregated as 'teachers of existing subjects'. *In the non-using schools* data were collected from principals and from teachers of mathematics, science and mother tongue (referred to as teachers of other subjects).
Excluded from our analysis are those strata from which data of less than 50 respondents were available; which appear to be the principals of non-using schools in France and the Netherlands. The same stratum is non-existent in the USA, as all schools in the sample are using computers.
The problems in using computers, cq. the reasons for non-use are divided into five categories: hardware, software, instruction, organization, and other.
Table 1 contains a general overview of the problems (and reasons for non-use), as well as the percentage of respondents per stratum.

-----ABOUT HERE TABLE 1 OF APPENDIX-----

Exploratory analysis

A first conclusion from the data is that there are clearly some 'non-problems':

- nr. 14: hardly anybody believes that the use of computers is inappropriate for students in secondary school; a percentage >10 is only found for non-using principals and teachers in Japan;
- nr. 20: the lack of availability of computers in school, is only mentioned by a meaningful percentage of principals of non-using schools (58%) and non-using teachers (29%) in Japan;
- nr. 26: that the use of computers would not fit in the school's policy is neither a problem, nor an argument for not using computers; the only percentage >10 is found among the non-using principals in Japan.

One way of determining the most important obstacles in using computers is looking at the items which do have the highest percentages. Per stratum the scores on the 28 items in Table 1 are rank-ordered, and only the five most important ones are selected. Table 2 contains those items which are most frequently mentioned, with their rank order per stratum:

-----ABOUT HERE TABLE 2 OF APPENDIX-----

- nr. 27, not enough time to develop lessons with computers: this is an important problem across categories; all categories of using and non-using teachers of existing subjects have this time problem in the top five;
- nr. 1, insufficient computers available: here Japan is clearly different from the other countries, where this item belongs to the top five in all categories of respondents, users as well as non-users;
- nr. 5, not enough software for instructional purposes available: although this one is not among the top five of the using principals and computer coordinators in France, it should be notified that all categories of using teachers in all four countries have the lack of enough software as the number 1 or 2 problem;
- nr. 15, teachers lack knowledge: all non using categories mention this as one of the most important reasons for not being involved in using computers. It is interesting to observe that in all four countries the principals and computer coordinators mention lack of knowledge of teachers as an important problem, while in France, the Netherlands and the USA the category of using teachers of mathematics, science and mother tongue does not have this in the top five. This suggests that many using teachers, who are no specialists in the area of computers, do not see their level of knowledge as a major obstacle;
- nr. 12, integration in classroom practice: given the scores, one might call this one a 'second level' problem. In Japan, other problems are apparently more dominant; but according to the computer coordinators in France, the Netherlands and the USA this is a major problem in the schools. Non-using teachers also score this item in the top five.

Looking at the top-five problems does not take into account that the percentage scores may differ enormously between countries. For example, the most important problem in the category using principals in the USA has a score of 77%, which is the percentage of the number four problem in Japan; and, in the same category, the number five problem in the USA has a lowe. percentage (48%) than the number 17 in Japan. We therefore marked all scores with a percentage of 50 or higher. The results are shown in Table 3.

-----ABOUT HERE TABLE 3 OF APPENDIX-----

First, the results of Table 3 confirm those based on Table 2: the same four items appear to be the top four obstacles. It should be noticed that they all refer to conditional problems. They have to do with lack of hardware, software, knowledge and time. Clearly, users as well as non-users feel that these conditional factors are primary obstacles: what users experience as major problems, are reasons for non-users (who must have heard about these problems, as they are not experiencing these themselves!) not to invest time and other efforts in getting involved with using computers.
Secondly, visual inspection of Table 3 reveals some interesting phenomena. It is obvious that the Japanese educators at all levels in junior secondary schools feel that

they experience most problems. Some of the problems do only have in Japan scores higher than 50%, such as 'no room in the time table to let students learn about computers' (17), 'not enough technical assistance for operating and maintaining computers' (19), 'insufficient training opportunities for teachers' (23), 'lack of support or initiatives from administrators' (24), and 'inadequate financial support' (25). If we compare these factors with those mentioned in the literature on implementation of change as important for influencing the implementation process (e.g. Fullan, 1982; Fullan, Miles & Anderson, 1988), then we must conclude that many Japanese schools still struggle with the basic and absolute necessary implementation conditions. Whether this special position of Japan is due to the rather late start of a national stimulation policy (1985: the national government started to subsidize half of the amount necessary for the purchase of hardware), or whether (also) other factors are playing a role needs further analysis. It might be that the repeated survey in 1992 will shed more light on this.

Another observation from Table 3 is that in all countries principals and computer coordinators experience many more problems than computer using teachers. Further, the low number of items scored higher than 50% by non-using teachers in France, the Netherlands and the USA suggests that non-users apparently mention a variety of reasons for not being involved with computers in their instructional practice; 'teachers lack knowledge of and skills for using computers for instructional purposes' (15) is the only reason which has a score higher than 50% in two countries .

Contrast analysis

To find out if there is any relationship between the degree of implementation of computer use and the type of problems which are experienced, a comparison was made between the intensive using schools and the relative 'light' using schools. To distinguish these two groups for each country a measure indicating the level of computer use was calculated. This was done by counting per grade level the number of subjects in which computers were used. For example, if in a school in grade 7 in three subjects computers are being used, in grade 8 in four subjects, and in grade 9 in two subjects, then for this school this variable has the value 9. After ranking the schools for each country on this score, the upper thirty per cent was identified as the schools with a high level of computer use and the lower thirty per cent as the schools with a low level of computer use. The intermediate forty percent of cases was left of the contrast analysis. Because the information from the technical questionnaire was used for establishing the level of computer use, all schools without a completed technical questionnaire were excluded. Also categories with less than 50 cases were excluded. For this reason the using teachers in existing subjects from the Netherlands are not included in the contrast analyses.

Table 4 shows the mean and the standard deviation of the scores that underlies the level of computer use for each of the countries.

Table 4

Mean and standard deviation of the score indicating the grades and subjects in which computers are used

	low use		high use	
	mean	sd	mean	sd
France	4.3	1.5	14.8	3.0
Japan	2.0	0.8	10.4	5.0
Netherlands	1.5	0.5	9.7	3.5
USA	2.8	1.1	13.2	3.7

Looking at the mean-scores it becomes clear that the level of computer use differs between countries. The reason for these differences is that the level of use score represents a relative measure which is related to the specific situation in a country. As noted before in France 'teaching about computers' is part of other courses and in the Netherlands it is a separate course at most schools. This could be the reason why for example in the low use category, the mean score in France is nearly three times as high as in The Netherlands.

Per stratum, the percentages of respondents in schools with a high (h) and schools with a low (l) level of computer use are presented in Table 5, in which also the significant differences at 5% and 10% level are indicated.

-----ABOUT HERE TABLE 5 OF APPENDIX-----

The results from the contrast analyses illustrate that the significant differences between high and low level of computer use are mostly such that low level using schools experience more problems (arrow downwards in table 5). In a limited number of cases schools with a high level of computer use have more problems with a possible obstacle than schools with a low level of computer use (arrow upwards in table 5). In France, the Netherlands and the USA the number of significant differences between low and high level use is small. Also the mean number of problems marked by respondents in the questionnaires (see at the bottom of table 5) between low and high level use hardly differs in these countries. This in contrast with Japan where low and high level use vary widely especially in problems related to the organizational aspect of computer use; the mean number of problems at high level use is always below the low level use.
As mentioned before the most important obstacles are: lack of hardware, software, knowledge and time. The contrast analyses answer the question whether schools with a high level of use have succeeded more in overcoming these problems than schools with a low level use.
For the Netherlands and the USA the insufficient availability of computers is as big an obstacle for both levels of computer use. In France a difference appears only with the using teachers in existing subjects; the other categories of respondents feel no difference in the degree of lack of computers. In Japan all categories of respondents

differ widely which indicates that availability of hardware is a cause for the difference between low and high level use.
The availability of software is a similar problem for nearly all strata at both levels of use. Only in the USA the principals of schools with a high level use experience the lack of software (significantly) less as a problem than their colleagues of schools with low level use. In France we see a reverse picture with the principals.
The lack of knowledge of teachers in Japan, the Netherlands and the USA is approximately equal in both levels of use. Only France has significant differences in three out of four categories of respondents which shows that the amount of knowledge teachers have in using computers differs widely between low and high level use, which might be related to the fact that most 'learning about computers' takes place via existing subjects.
In most cases the availability of time for developing lessons is a comparable problem for both levels of use. It is interesting that the three significant differences herein have to do with teacher level and show a growth of this problem when computer use at school level increases. When we look at the five most important problems (calculated as in table 3) in each category we find that there is hardly any difference in the kind of problems between low and high level use. For both levels the four conditional factors: lack of hardware, software, knowledge and time are the most important obstacles in implementing computers. Within countries we generally find that the percentages of problems in schools with low use exceed those at high level use. As mentioned before the percentages between countries mutually vary enormously.

As consequence of the complexity in table 5 where a distinction was made between the different respondent categories it is rather difficult to get a general overview at country level. For that reason we aggregated a score on the problem list for each school. This was done by calculating the mean score for the respondent categories on each of the items on the problem list. If information was available from more than one teacher within a respondent categorie, first a mean score for the teacher categorie was calculated. All mean scores lower than .5 were recoded to 0 (no problem) and scores higher or equal to .5 were recode to 1 (a problem). Table 6 shows the results from the aggregated date for schools with low (l) and high (h) level of use. The significant differences at 5% and 10% level are indicated.

-----ABOUT HERE TABLE 6 OF APPENDIX-----

In France we find seven significant differences between the low and high level of use. There is one problem that increases at high level of use: the software is not adaptable enough. The other six problems, which are more serious at low level of use, are associated with instructional (teachers lack knowledge and insufficient expertise to help teachers) and organizational problems (no room in time table, not enough computer location space, insufficient technical assistence and insufficient training

opportunities).
The differences between schools with low and high level of use in Japan are numerous. All differences show a decrease of the problems at schools with a high level of use. Interesting is that the percentage of schools in Japan with insufficient computers at low level of use is equal or higher compared to the other countries; and at high level of use the percentage of schools with insufficient computers is the lowest of the four countries. The greatest difference in Japan between the high and low level of use concerns the problem: 'not enough computer location space' (18). As seen before in the context of table 5, most of the significant differences are related to organizational aspects.
The comparison shows four (significant) differences in The Netherlands. These differences are related to limitations of computers, integration in instruction, school educational policy and training opportunities. Only the latter problem is more serious for the high level of use than for the low level.
In the USA we find eight significant differences between low and high level of use. All of them show less problems at schools with a high level of use. The differences are related to the problem areas: availability of hardware, organizational aspects and teacher interest. The greatest difference (32%) between both levels has to do with the access for teachers' own use.

Conclusions

With respect to our first research question, we conclude that the most important problems of computer users are at the same time the most important reasons for non-users for their not being involved in using computers for instructional purposes. These problems in implementing computers in education, experienced by principals, computer coordinators and teachers, are related to what we called the conditional factors: lack of hardware, software, knowledge and time.
With respect to the second research questions our conclusions are not so straight forward. Although we found great differences in the degree of computer implementation at high and low level of use within countries as well as between countries, the four most important problems are mostly the same for both levels of use. It seems that as long as the conditional factors are not fulfilled, they have a cramping effect on the ongoing of implementing computers in education.
Besides the equality of the most important problems at both levels of use, we also found differences between the low and high level of computer use. The most important differences between schools with low and high level of use are associated to organizational aspects. Schools with high level of use have more often overcome organizational problems such as: no room in time table, not enough computer location space, insufficient technical assistence, insufficient access for teachers' own use and insufficient training oportunities.

At this moment it is not clear that, once conditional problems would be solved, the integration of computers in education might proceed without major problems. From the current state of affairs we know that there is hardly any school without problems on the conditional factors. When the survey will be repeated in 1992, we expect to have data from more schools which have overcome the conditional factors. It will be interesting to see whether the integration of computers in education proceeds without major problems at these schools or that a second layer of problems becomes manifest.

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Table 1
Percentage of respondents per stratum with problems in using schools and reasons for non-use

	FRA use			FRA n-u	JPN use				JPN n-u		NET use				NET n-u	USA use				USA n-u
	SPR	SCC	TES	TES	SPR	SCC	TCE	TES	SPR	TES	SPR	SCC	TCE	TES	TES	SPR	SCC	TCE	TES	TES
Hardware																				
1 Insufficient computers available	56	65	53	42	65	65	63	36	61	64	59	52	46	44	33	77	64	41	58	57
2 Insufficient peripherals avail le	33	22	12	9	64	66	65	42	58	57	40	35	42	30	8	60	52	49	35	11
3 Difficulty with maintenance	36	52	44	13	34	33	42	26	57	45	19	23	26	19	3	13	16	30	11	3
4 Limitations of computers	52	61	44	12	31	35	34	33	m	17	16	23	16	12	4	30	29	34	16	12
Software																				
5 Not enough software for instruction	41	53	65	35	85	96	94	92	68	77	74	71	63	72	49	48	49	44	46	40
6 Software too difficult	21	29	16	8	47	50	39	36	54	51	23	40	34	33	12	7	5	7	4	5
7 Software not adaptable enough	50	49	50	38	72	73	70	66	58	64	48	44	41	23	19	23	24	16	18	20
8 Poor quality of manuals	22	32	17	7	50	56	50	36	44	40	13	15	20	14	4	11	15	17	11	3
9 Lack of information about software	56	64	39	39	69	76	65	63	66	65	23	28	22	16	17	18	16	16	18	26
10 Software not in instruction language	4	3	0	1	33	20	19	16	45	29	11	10	15	14	5	m	m	m	m	m
Instruction																				
11 Not enough supervising help	45	41	26	26	50	48	47	30	73	66	24	25	26	21	13	38	34	26	27	26
12 Integration in instruction a problem	81	73	30	43	57	58	46	48	65	0	57	60	44	16	34	34	53	10	27	46
13 Integration in curriculum a problem	39	m	32	34	56	m	54	49	59	57	34	m	m	21	31	34	m	8	19	22
14 Inappropriate for students age level	1	1	0	2	8	7	10	3	19	12	0	0	3	0	1	1	1	0	1	2
15 Teachers lack knowledge	78	72	27	50	79	82	63	63	81	78	58	74	54	23	36	77	79	10	22	54
16 Insuff. expertise to help teachers	56	58	20	33	58	69	58	55	68	60	39	40	41	7	24	20	28	16	10	26
Organization																				
17 No room in time-table	33	46	36	36	58	63	51	49	60	64	39	42	32	28	32	34	13	30	26	25
18 Not enough computer location	24	27	17	15	40	34	26	16	60	50	18	13	11	7	14	32	28	27	28	27
19 Insuff. techn. operating assistance	28	31	23	15	65	66	63	45	71	64	30	26	20	9	9	25	23	23	15	19
20 Computers only outside school	0	0	0	1	9	5	3	4	58	29	0	0	1	0	1	1	1	1	3	2
21 Problems scheduling enough time	52	50	51	55	65	55	52	43	61	57	38	32	30	26	13	42	37	19	40	38
22 Insuff. access for teachers own use	8	8	12	8	46	45	22	25	78	54	17	14	16	19	9	35	22	8	18	31
23 Insufficient training opportunities	31	45	17	28	77	86	71	60	76	79	18	19	27	7	16	42	53	21	20	32
24 Lack of administrative support	24	24	5	4	37	53	33	30	64	56	5	16	22	9	6	8	17	12	7	11
25 Inadequate financial support	22	24	9	4	70	75	72	26	77	64	44	36	35	12	12	34	37	36	24	26
26 No fit in school educational policy	2	1	0	0	10	10	0	0	20	0	0	4	0	0	0	1	0	0	0	0
Other																				
27 Not enough time to develop lessons	44	59	46	46	81	87	88	85	72	79	64	75	70	67	49	57	68	19	42	45
28 Teachers lack interest	68	60	29	9	26	38	35	34	25	23	23	44	38	19	10	35	52	27	13	11

Legend:
FRA = France
JPN = Japan
NET = the Netherlands
SPR = School Principal
SCC = School Computer Coordinartor
TCE = Teacher of Computer Education
TES = Teacher of Exixting Subjects (math, science and mother tongue)
n-u = non-use
m = question not stated

Table 2
The most important problems based on rank ordering in each stratum the five most important problems

	FRA use			FRA n-u	JPN use				JPN n-u		NET use				NET n-u	USA use				USA n-u	COUNT use	COUNT n-u	COUNT tot
	SPR	SCC	TES	TES	SPR	SCC	TCE	TES	SPR	TES	SPR	SCC	TCE	TES	TES	SPR	SCC	TCE	TES	TES			
Hardware																							
1 Insufficient computers available	4-6*	3	2	5							3	5	4	3	5	1-2	3	3	1	1	11	3	14
2 Insufficient peripherals available														5		3		1	5		4	-	4
4 Limitations of computers		5																5			2	-	-
Software																							
5 Not enough software for instruction			1		1	1	1	1		4	1	3	2	1	1-2	5		2	2	5	12	3	15
6 Software too difficult														4							1	-	1
7 Software not adaptable enough			4		5		5	3													4	-	4
9 Lack of information about software	4-6*	4				5		4-5													4	-	-
Instruction																							
11 Not enough supervising help									5	5											-	2	2
12 Integration in instruction a problem	1	1		4							5	4	5		4		4-5			3	6	3	9
15 Teachers lack knowledge	2	2		2	3	4		4-5	1	3	4	2	3		3	1-2	1			2	10	5	15
16 Insuff. expertise to help teachers	4-6*																				1	-	-
Organization																							
21 problems scheduling enough time			3	1															4		2	1	3
22 Insuff. access for teachers own use									2												-	1	1
23 Insufficient training opportunities					4	3	4		4	1-2							4-5				4	2	6
25 Inadequate financial support							3		3									4			2	1	3
Other																							
27 Not enough time to develop lessons		5	3		2	2	2	2		1-2	2	1	1	2	1-2	4	2		3	4	12	4	16
28 Teachers lack interest	3																				1	-	1

Legend:
FRA = France
JPN = Japan
NET = the Netherlands
SPR = School Principal
SCC = School Computer Coordinartor
TCE = Teacher of Computer Education
TES = Teacher of Existing Subjects (math, science and mother tongue)
n-u = non-use
4-6* = problems 1, 9 and 16 ex aequo number 4

Table 3
Overview of problems with a percentage of 50 or higher

	FRA use			FRA n-u	JPN use				JPN n-u		NET use				NET n-u	USA use				USA n-u	COUNT use	COUNT n-u	COUNT tot
	SPR	SCC	TES	TES	SPR	SCC	TCE	TES	SPR	TES	SPR	SCC	TCE	TES	TES	SPR	SCC	TCE	TES	TES			
Hardware																							
1 Insufficient computers available	0	0	0		0	0	0		0	0	0	0				+	0		0	0	11	3	14
2 Insufficient peripherals available					0	0	0		0	0						0	0				5	2	7
3 Difficulty with maintenance		0							0												1	1	2
4 Limitations of computers	0	0							m												2	-	2
Software																							
5 Not enough software for instruction		0	0		+	+	+	+	0	+	0	0	0	0							10	2	12
6 Software too difficult						0			0	0											1	2	3
7 Software not adaptable enough	0		0		0	0	0	0	0	0											6	2	8
8 Poor quality of manuals					0	0	0														3	-	3
9 Lack of information about software	0	0			0	+	0	0	0	0											6	2	8
10 Software not in instruction language																m	m	m	m	m	-	-	-
Instruction																							
11 Not enough supervising help					0				0	0											1	2	3
12 Integration in instruction a problem	+	0			0	0			0		0	0					0				7	1	8
13 Integration in curriculum a problem		m			0	m	0		0	0		m	m				m				2	2	4
14 Inappropriate for students age level																					-	-	-
15 Teachers lack knowledge	+	0		0	+	+	0	0	+	+	0	0	0			+	+			0	11	4	15
16 Insuff. expertise to help teachers	0	0			0	0	0	0	0	0											6	2	8
Organization																							
17 No room in time-table					0	0	0		0	0											3	2	5
18 Not enough computer location									0	0											-	2	2
19 Insuff. techn. operating assistance					0	0	0		0	0											3	2	5
20 Computers only outside school									0												-	1	1
21 Problems scheduling enough time	0	0	0	0	0	0	0		0	0											6	3	9
22 Insuff. access for teachers own use									+	0											-	2	2
23 Insufficient training opportunities					+	+	0	0	+	+								0			5	2	7
24 Lack of administrative support						0			0	0											1	-	3
25 Inadequate financial support					0	+	+		+	0											3	2	5
26 No fit in school educational policy																							
Other																							
27 Not enough time to develop lessons		0			+	+	+	+	0	+	0	+	0	0		0	0				11	2	13
28 Teachers lack interest	0	0															0				2	-	-
Total ≥ 50%	9	11	4	2	17	17	15	7	22	19	5	5	3	2	-	4	7	-	1	2			

Legend:
FRA = France
JPN = Japan
NET = the Netherlands
SPR = School Principal
SCC = School Computer Coordinartor
TCE = Teacher of Computer Education
TES = Teacher of Existing Subjects (math, science and mother tongue)
0 = 50 ≤ % < 75
\+ = 75 ≤ % ≤ 100
n-u = non-use
m = question not stated

Table 5

Comparison of problems between schools with a high and schools with a low level of computer use

	FRANCE								JAPAN										NETHERLANDS								USA							
	use						n-u		use								n-u		use						n-u		use						n-u	
	SPR		SCC		TCE		TES		SPR		SCC		TCE		TES		TES		SPR		SCC		TCE		TES		SPR		SCC		TCE		TES	
	l	h	l	h	l	h	l	h	l	h	l	h	l	h	l	h	l	h	l	h	l	h	l	h	l	h	l	h	l	h	l	h	l	h
number of cases	65	70	11	41	16	45	61	70	67	82	82	82	83	44	59	24	61	77	58	48	56	58	66	36	45	37	37	70	84	83	98	40	55	18	62	39	36
Hardware																																					
1 Insufficient computers available	61	56	72	64	**71↓49**		54	48	**71↓53**		**74↓54**		**77↓49**		**63↓33**		**64↓29**		65	59	48	52	44	42	30	32	80	77	63	59	45	49	67	69	56	56
2 Insufficient peripherals available	27	31	23	20		**9↑21**	11	7	**76↓51**	69	60	59	71	54	48	**57↓29**			48	39	22	38	36	51	5	14	61	61	55	45	45	44	44	44	21	11
3 Difficulty with maintenance	39	37	57	55	47	43	17	18	38	34	36	34	39	41	33	33	53	41	17	27	22	27	28	22	5	3	14	12	**22↓11**		33	29	11	11	10	0
4 Limitations of computers	57	46	**52↑76**		44	43	19	13	28	30	33	35	30	36	33	41	12	9	19	13	29	21	25	13	8	5	**37↓25**		**40↓19**		**28↑49**		17	24	13	14
Software																																					
5 Not enough software for instruction	**34↑50**		54	53	71	69	41	40	90	91	98	98	91	97	96	95	88	84	71	79	76	68	67	64	49	49	**64↓38**		49	41	35	38	50	58	51	44
6 Software too difficult	22	20	26	27	16	10	9	13	**56↓38**	48	49	32	41	42	44	**73↓48**			23	27	43	45	47	38	11	14	6	11	2	7	8	9	0	8	3	3
7 Software not adaptable enough	42	54	47	53	53	59	36	46	**79↓67**		**79↓67**		70	73	71	70	68	74	**54↓32**		41	38	47	47	19	22	29	29	25	22	18	13	22	24	15	22
8 Poor quality of manuals	21	19	34	27	18	23	13	6	52	51	57	53	**34↑54**		38	43	**53↓34**		17	9	14	23	25	29	8	5	13	12	16	10	20	22	11	18	5	3
9 Lack of information about software	48	54	58	67	38	49	47	43	**85↓59**	80	7c	64	61	75	69	75	69		33	21	22	35	31	24	22	14	21	21	13	16	**5↑20**		11	23	21	22
10 Software not in instruction language	3	1	4	1	0	2	1	3	**40↓28**	21	19	16	19	17	13	26	28		13	9	14	12	14	11	5	8	m	m	m	m	m	m	m	m	m	m
Instruction																																					
11 Not enough supervising help	51	39	**47↓34**		36	26	29	27	**61↓33**		57↓42		**59↓36**		42	31	**70↓53**		27	20	21	23	25	29	16	11	34	39	31	29	28	18	28	32	28	22
12 Integration in instruction a problem	81	80	71	68	31	23	46	42	**66↓41**		**69↓48**		**61↓32**		54	59	m	m	**65↓48**		64	61	53	36	**57↓35**		33	38	51	57	5	5	28	34	54	56
13 Integration in curriculum a problem	43	37	m	m	38	41	43	46	**65↓48**	m	m		**64↓44**		58	52	61	59	44	32	m	m	0	0	43	41	41	39	m	m	3	9	11	24	23	31
14 Inappropraite for students age level	1	0	1	0	0	0	3	4	9	6	10	6	11	10	4	3	16	7	0	0	2	0	6	7	0	3	1	0	2	1	0	0	0	2	3	3
15 Teachers lack knowledge	**82↓70**		72	72	**40↓25**		**64↓46**		82	74	85	81	68	56	58	72	**92↓83**		56	50	72	68	58	47	35	49	80	75	77	80	**18↓ 2**		17	31	49	64
16 Insufficient expertise to help teachers	51	59	54	59	27	15	44	31	**72↓44**		68	67	64	51	71	64	66	59	38	39	34	41	42	36	24	22	23	21	22	32	18	18	11	10	33	19
Organization																																					
17 No room in time table	37	26	51	40	**49↓31**		50	39	**66↓52**		69	58	57	42	67	54	**73↓48**		44	39	48	42	**42↓20**		35	38	31	36	**22↓ 7**		35	33	39	24	26	22
18 Not enough computer location	25	20	33	17	**24↓11**		21	16	**48↓21**		**46↓25**		**41↓14**		29	13	**47↓17**		17	13	22	14	8	9	19	16	36	27	30	26	**45↓22**		39	29	23	36
19 Insuff. technical operating assistence	**36↓23**		35	25	33	20	24	13	**78↓46**		72	60	**70↓53**		58	48	**71↓43**		**48↓18**		31	30	25	20	0	11	**34↓18**		24	22	18	24	17	13	26	22
20 Computers only outside of school	0	0	0	0	0	0	0	0	**11↓ 1**		**10↓ 0**		**9↓ 0**		8	3	**19↓ 7**		2	0	0	2	3	2	3	0	0	1	1	0	0	0	0	2	0	3
21 Problems scheduling enough time	57	47	44	59	64	51	57	60	**71↓59**		56	52	50	53	50	49	60	52	33	34	26	36	31	31	19	14	42	46	34	42	15	22	56	56	38	53
22 Insuff. access for teachers own use	7	4	7	7	7	13	13	6	**56↓27**		**57↓30**		18	20	42	28	**51↓33**		21	11	17	11	11	16	8	14	31	33	25	20	10	5	28	24	33	25
23 Insufficient training opportunities	39	27	46	44	24	13	**39↓19**		82	76	**91↓82**		**80↓64**		67	69	88	79	15	21	16	24	22	38	19	11	**54↓29**		59	49	**30↓15**		11	24	33	19
24 Lack of administrative support	**16↑30**		24	25	7	7	7	6	**45↓24**		**64↓45**		**50↓20**		46	33	47	34	6	4	19	23	28	18	0	8	11	8	14	14	13	13	6	10	10	8
25 Inadequate financial support	19	23	18	25	7	8	4	4	**77↓57**		**81↓66**		**80↓64**		21	31	**65↓47**		**58↓38**		31	41	31	40	11	11	**41↓27**		37	33	30	38	33	32	26	22
26 No fit in school educational policy	3	1	1	2	0	0	m	m	11	10	11	6	m	m	m	m	m	m	0	0	**10↓ 0**		m	m	m	m	0	0	0	0	0	0	0	0	0	0
Other																																					
27 Not enough time to develop lessons	42	43	50	59	**44↑61**		54	46	82	88	85	89	89	86	88	89	87	86	60	64	67	77	**64↑82**		46	62	67	58	67	72	15	22	39	53	**36↑61**	
28 Teachers lack interest	76	67	58	59	27	26	9	6	28	20	43	35	34	39	33	49	21	16	21	23	34	39	31	31	5	11	**41↓27**		51	51	35	25	22	13	5	17
Mean number of problems	10	10	11	11	8	7	7	6	16	12	16	13	14	12	13	10	12	10	9	8	9	9	9	8	5	5	10	8	9	8	6	5	6	6	6	6

Notes: l = low level of computer use; h = high level of computer use

underlined = significant χ^2-value at ten percent level; **bold and underlined** = significant χ^2-value at five percent level

SPR = School Principal User; SCC = School Computer Coordinator User; TCE = Teacher Computer Education User; TES = Teacher Existing Subject User;

Table 6

Comparison on aggregated data for problems between schools with high and low level of computer use

	FRANCE		JAPAN		NETHERLANDS		USA	
	l	h	l	h	l	h	l	h
number of cases	114	116	82	83	58	66	83	98
Hardware								
1 Insufficient computers available	64	62	**74** ↓	**41**	47	48	74	68
2 Insufficient peripherals available	17	14	65	57	29	42	53	46
3 Difficulty with maintenance	37	39	40	29	20	26	24 ↓	13
4 Limitations of computers	41	40	20	28	**27** ↓	**12**	**36** ↓	**21**
Software								
5 Not enough software for instruction	56	61	100	95	75	74	**58** ↓	**43**
6 Software too difficult	13	17	56	46	34	41	2	3
7 Software not adaptable enough	50 ↑	60	80	81	39	36	22	16
8 Poor quality of manuals	20	17	48	43	19	17	12	10
9 Lack of information about software	50	59	**86** ↓	**69**	25	26	14	15
10 Software not in instruction language	1	1	20	11	12	8	m	m
Instruction								
11 Not enough supervising help	41	34	**67** ↓	**37**	24	26	33	29
12 Integration in instruction a problem	61	54	27	28	**66** ↓	**47**	41	37
13 Integration in curriculum a problem	42	45	60	52	19	14	21	20
14 Inappropraite for students age level	3	2	6	6	3	0	0	0
15 Teachers lack knowledge	**68** ↓	**52**	89	84	63	55	64	53
16 Insufficient expertise to help teachers	47 ↓	36	77 ↓	64	29	33	22	19
Organization								
17 No room in time table	**50** ↓	**35**	**78** ↓	**57**	42	39	35 ↓	22
18 Not enough computer location	**24** ↓	**14**	**51** ↓	**16**	19	11	**42** ↓	**27**
19 Insuff. technical operating assistence	**28** ↓	**16**	**80** ↓	**49**	25	20	24	18
20 Computers only outside of school	0	0	**11** ↓	**2**	3	0	0	0
21 Problems scheduling enough time	64	62	**72** ↓	**54**	29	32	36	44
22 Insuff. access for teachers own use	10	8	**48** ↓	**18**	14	9	**34** ↓	**13**
23 Insufficient training oppertunities	**40** ↓	**22**	**94** ↓	**77**	**14** ↑	**30**	**51** ↓	**19**
24 Lack of administrative support	11	13	**49** ↓	**27**	17	15	12	5
25 Inadequate financial support	6	8	**75** ↓	**54**	29	32	38	31
26 No fit in school educational policy	3	3	21	12	**10** ↓	**0**	0	0
Other								
27 Not enough time to develop lessons	55	58	93	92	73	80	59	58
28 Teachers lack interest	34	30	25	25	22	27	36 ↓	23

l = low level of computer use; h = high level of computer use

underlined = significant χ^2-value at ten percent level; **bold and underlined** = significant χ^2-value at five percent level